

# 2007 Assessment of the Biology, Habitat and Chemistry of Streams in the Upper Swift Creek Watershed, Chesterfield County, Virginia



Horsepen Creek upstream of Otterdale Road, Spring 2007

# Chesterfield County Department of Environmental Engineering Water Quality Section

## Upper Swift Creek Watershed Stream Assessments

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### **Executive Summary**

This report presents the biological, physical and chemical water quality data collected by Chesterfield County's Office of Water Quality over the period of 2002 to 2007 focusing on the streams of the Upper Swift Creek Watershed. Over the past five years, 12 sites have been monitored and assessed in the Upper Swift Creek Watershed. Most recent biological assessments were divided among the "Moderately Impaired", "Slightly Impaired" and "Non Impaired" categories.

Habitat assessments since 2002 have demonstrated that the majority of the streams investigated in the Upper Swift Creek Watershed possess either "Non-Supporting" or "Partially Supporting" habitat. As in 2006, four of the six assessed sites possessed "Non-Supporting" habitat in 2007.

A comprehensive suite of chemical parameters has been collected since 2002 to provide a general water quality "snapshot" at the time the biological and habitat assessments are obtained. For the past five years, instream measurements of dissolved oxygen, conductivity, total dissolved solids and temperature have been normal. While observations of pH over the years have shown several streams to have values less than 6.0 units, no streams in the Upper Swift Creek Watershed possessed pH values lower than this threshold in 2007. Fecal coliform densities observed in the tributaries of the Upper Swift Creek Watershed have largely been below the Virginia State one-time sampling standard of 400 MPN/100ml with no violations noted in 2007. Overall nutrient concentrations in 2006 were slightly greater than values observed in 2006. In 2007, all measurements of total suspended solids were less than or equal to 5 mg/L. Since 2002, the majority of Biological Oxygen Demand determinations have been less than 3.0 mg/L, with values for 2007 all less than the reporting limit of the laboratory (2.0 mg/L). Hardness measurements during the past five years have indicated soft water (<85 mg/L as CaCO<sub>3</sub>) throughout the Upper Swift Creek Watershed.

An index of water quality using the biological data, habitat assessment and select chemical parameters has been used to provide for an overall evaluation of stream health in the County. In 2007, improvements in stream health were noted at Swift Creek (B-034), Horsepen Creek (B-035) and at Westbranch (B-037. The only decline in index category score during 2007 was noted at Otterdale Branch (B-028) where the value decreased from a "Very Good" to a "Fair" status. The remaining two sites demonstrated no change from the previous year.

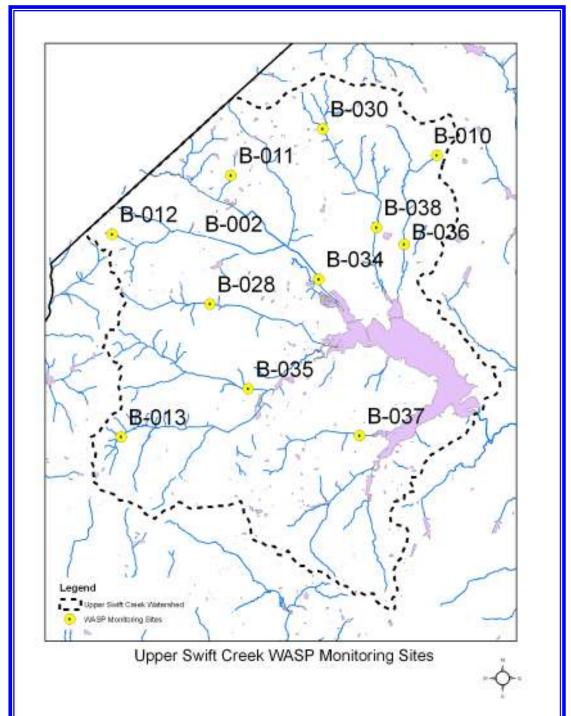
### **Introduction:**

This report presents the biological, physical and chemical water quality data collected by Chesterfield County's Department of Environmental Engineering, Water Quality Section over the period of 2002 to 2007 focusing on the streams of the Upper Swift Creek Watershed. As a component of Chesterfield County's VPDES Permit VA0088609, Watershed Assessment and Stream Protection (WASP) Program, investigations are conducted each spring throughout the County to assess the condition of its waters. Since this watershed-based approach to sampling began in 2002, twelve sites have been monitored and assessed in the Upper Swift Creek Watershed (Table 1).

These sites, as well as others in the program, were selected by a careful review of maps produced from the County's Geographic Information System. At each site, biological and habitat assessments followed the guidelines outlined in the Environmental Protection Agency's Revised Rapid Bioassessment Protocol (EPA, 1999). Physical and chemical water quality was determined by in stream measurements and laboratory analyses of collected samples. The aforementioned assessments and data have been used to produce an overall index of water quality for the streams of the watershed.

Table 1. Locations and years for which data is available for sites in the Upper Swift Creek Watershed.

Site Number	<u>Stream</u>	Station Location	Years Monitored
B-002	Turkey Creek	Upstream of Mount Hermon Road	2002 - 2004
B-010	Little Tomahawk Creek	Across from JTCC @Charter Colony Parkway	2002 - 2005
B-011	Tributary to Swift Creek	Downstream of Mount Hermon Road	2002 - 2005
B-012	Turkey Creek	Downstream of Mosley Road	2002 - 2003
B-013	Blackman Creek	End of Ledo Road	2002
B-028	Otterdale Branch	At Clover Hill Athletic Complex	2002 - 2007
B-030	Tomahawk Creek	Downstream of RR Crossing off Dry Bridge Road	2002 - 2005
B-034	Swift Creek	Downstream of Otterdale Road	2003 - 2007
B-035	Horsepen Creek	Upstream of Otterdale Road	2004 - 2007
B-036	Little Tomahawk Creek	Holding Pond Lane	2004 - 2007
B-037	West Branch	Upstream of West Branch Road	2006 - 2007
B-038	Tomahawk Creek	Downstream of Old Hundred Road	2006 - 2007



Map 1. Location of WASP monitoring sites in the Upper Swift Creek Watershed

### **Results:**

The following pages describe each site and contain a summary of the observations made at each stream. Photos depict the upstream view of the site unless otherwise noted. Left and right banks are referenced from the perspective looking upstream.

Stream: Turkey Creek

Site: Immediately Upstream of

Mount Hermon Road

Watershed: Upper Swift Creek

Subwatershed: Turkey Creek

Approximate Drainage Area

(acres): 1750

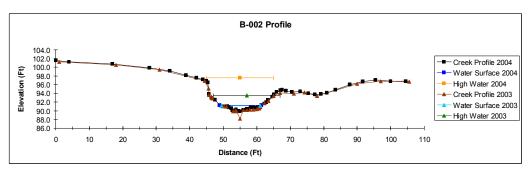
Stream Order: 2

Ecoregion: Triassic Basin (2)

Landuse: Mixed Forested, Low Density Residential and Agriculture



### **Stream Hydrologic Profile:**



### **Bioassessment:**

In 2004 the site was categorized as "Moderately Impaired", a downgrade from the "Slightly Impaired" status observed in 2003. Decreases in assessment categories have been observed since 2002. A substantial increase in the proportion of *Chironomidae* taxa present in the sample, as well as decreases in predators contributed to the lower score observed in 2004. Aside from midges, other taxa well represented in the sample included small minnow mayflies (*Baetidae*) and Scuds (*Cragonyx*).

### **Habitat Assessment:**

The assessment for 2004 indicated the stream exhibited "Non-Supporting" habitat. Unstable banks with little vegetative cover, combined with a narrow riparian zone width on both sides were the main reasons for the observed score. A slight decrease in pool variability was also noted. Despite this assessment, the benthic macroinvertebrate community does not seem to have been substantially impacted.

### Water Quality:

Stream pH (5.6 units) was below VADEQ's water quality standard (6.0 units). All other water quality analyses did not indicate any significant issues. Nutrient concentrations and fecal coliform densities were among the lowest observed during the spring sampling period.

Stream: Little Tomahawk Creek

Site: Charter Colony Parkway Across from John Tyler Community College

Watershed: Upper Swift Creek

Subwatershed: Little Tomahawk

Creek

Approximate Drainage Area

(acres): 200

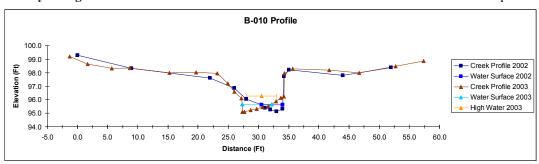
Stream Order: 1

Ecoregion: High River Terrace

(1)

Landuse: Residential and Commercial; New Construction

Stream Hydrologic Profile: Was not measured in 2004 or 2005 due to destruction of reference points.



### **Bioassessment:**

The bioassessments have steadily decreased from "Slightly Impaired" in 2002/2003 to "Moderately Impaired" in 2004 to "Severely Impaired" in 2005. Declines in percent predators recovered, lack of taxa variability and increases in pollution tolerant organisms were the major reasons for the lower score. The greatest HBI score (7.2) was observed at this site. Overall numbers of macroinvertebrates recovered in the sample (n = 58) were sparse with segmented worms (*Oligochaetes*) and midges (*Chironomidae*) the most common taxa observed.

### **Habitat Assessment:**

The degraded habitat ("Non-Supporting") observed in 2004 continued into 2005. This site possessed the lowest habitat assessment score (76) documented in 2005. The site has been significantly impacted by the construction of an apartment complex immediately adjacent to its banks. Loss of instream habitat, increased sedimentation, channel alteration, and encroachment into the riparian area were contributing factors.

### Water Quality:

Ammonia (0.07 mg/L), nitrate/nitrite (0.20 mg/L) and total phosphorus (0.035 mg/L) concentrations were elevated in 2005. Total hardness (48.9 mg/l), total suspended solids (19 mg/L) and Biological Oxygen Demand (13.8 mg/L) values were the greatest observed at all sites. All other parameters were acceptable. Within each category, this site was the most impaired stream segment monitored during 2005.

Stream: Tributary to Swift Creek

Site: Downstream of Mount

Hermon Road

Watershed: Upper Swift Creek

Subwatershed: Upper Swift

Creek

Approximate Drainage Area

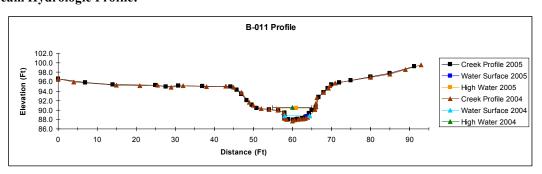
(acres): 730

Stream Order: 1

Ecoregion: Triassic Basin (2)

Landuse: Forested and Low Density Residential

### Stream Hydrologic Profile:



### **Bioassessment:**

The bioassessment improved during 2005 from "Moderately Impaired" to "Slightly Impaired". Bioassessments at this site have improved each year from the "Severely Impaired" status noted in 2002/2003. Improved EPT taxa richness (14 taxa recovered) and greater percentage of predators recovered were most responsible for the observed increase in the 2005 assessment. Midges (*Chironomidae*), common netspinner caddisflies (*Cheumatopsyche*) and *Baetidae* mayflies were the most commonly encountered organisms.

### **Habitat Assessment:**

The assessment score improved from the "Non-Supporting" condition observed in past years to "Partially Supporting" in 2004. Although poor bank stability and decreased vegetative bank cover remained present, improvements in epifaunal substrate/available cover, pool variability and channel flow status were recorded. Adequate rainfall for the past two years have enabled this stream to rebound from the effects of the drought and may be the reason behind the improvements noted for the past two years.

### Water Quality:

Slightly elevated concentrations of dissolved (0.057 mg/L) and total (0.081 mg/L) phosphorus were recorded. All other water quality analyses did not indicate any significant issues.

Stream: Turkey Creek

Site: Downstream Mosley Road

Watershed: Upper Swift Creek

Subwatershed: Turkey Creek

Approximate Drainage Area

(acres): 140

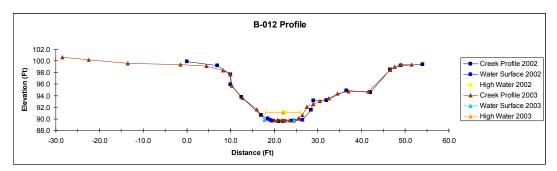
Stream Order: 1

Ecoregion: Triassic Basin (2)

Landuse: Forested and Low

Density Residential

### **Stream Hydrologic Profile:**



### **Bioassessments:**

Bioassessments declined from a "Moderately Impaired" status in 2002 to a "Severely Impaired" status during 2003. An overall loss of taxa richness and a decrease in the observed percent predator metric contributed to the downgraded category. Hilsenhoff Biotic Index scores were high for both years suggesting a biological community dominated by tolerant organisms. Predominant taxa included a variety of *Chironomidae* species, Amphipods (*Cragonyx spp.*) and the blackfly *Simulium*. Interestingly, perturbation sensitive macroinvertebrates as indicated by EPT richness were well represented for both years.

### **Habitat Assessment:**

In stream habitat assessment scores indicated a "Non-Supporting" condition for both years. Poor bank stability, decreased vegetative bank cover and riparian zone width contributed to the low scores observed. Heavy erosion was obvious along both banks for extensive areas.

### Water Quality:

pH values were slightly depressed during 2003 (5.5 units). All other analyses did not indicate any apparent problems with water quality.

Stream: Blackman Creek

Site: End of Ledo Road

Watershed: Upper Swift Creek

Subwatershed: Blackman Creek

Approximate Drainage Area

(acres): 320

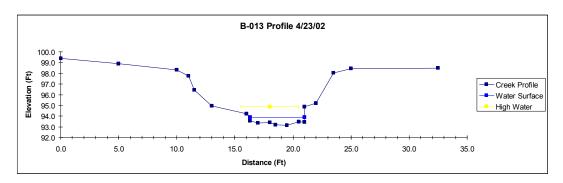
Stream Order: 1

Ecoregion: Triassic Basin (2)



Landuse: Forested with Recent Silvaculture

### **Stream Hydrologic Profile:**



### **Bioassessments:**

The monitoring conducted at Blackman Creek in 2002 was suspended in 2003 to allow for additional sites to be assessed in other watersheds. Bioassessments in 2002 indicated a "Non-Impaired" status. The site possessed high taxa richness and EPT taxa were abundant. Overall, benthic macroinvertebrate community structure was excellent and reflective of a well functioning stream system.

### **Habitat Assessment:**

In stream habitat assessment scores indicated a "Partially Supporting" condition for 2002. Recent logging in the watershed and in the immediate area of the stream decreased the riparian zone width scoring and influenced the overall status.

### Water Quality:

pH values were slightly depressed during 2003 (5.1 units). All other analyses did not indicate any apparent problems with water quality.

Stream: Otterdale Branch

Site: Behind Clover Hill Athletic Complex

Watershed: Swift Creek

Reservoir

Subwatershed: Otterdale

Branch

Approximate Drainage Area

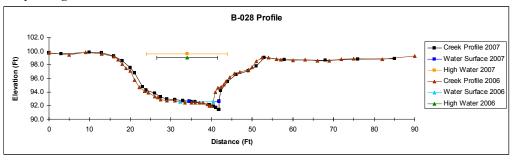
(acres): 1100

Stream Order: 2

Ecoregion: Triassic Basin (2)

Landuse: Forest, Ball fields, Park

### **Stream Hydrologic Profile:**



### **Bioassessment:**

In 2007, the assessment category indicated a decline from a "Slightly Impaired" to a "Moderately Impaired" status. Total taxa richness was similar to the previous year's value and EPT taxa richness was greater. Midge larvae (*Chironomidae*) numbers were high (69.5% of total sample) resulting in declines in both the percentage dominant taxa and percent collector/gatherer metrics. These two metrics were the major reason for the observed decline in the assessment category. The Hilsenhoff Biotic Index score was identical to the 2006 value and indicated a community comprised primarily of pollution tolerant organisms. An increase in predators recovered was noted during 2007 and no scraper taxa were observed. Other macroinvertebrates in the sample included predaceous diving beetles (*Hydroporus*), *Centroptilium* mayflies and biting midges (*Bezzia*).

### **Habitat Assessment:**

The instream habitat assessment score declined from a "Supporting" condition to a "Partially Supporting" status in 2007. Lower scores in the epifaunal substrate and available cover metrics as a result of increased sedimentation and lower instream flows all contributed to decreased assessment category. The riparian and bank structure metrics continued to score well in 2007.

### Water Quality:

The concentration of ammonia nitrogen (0.10 mg/L as N) was one of the greatest observed among all sites during 2007. Nitrate+nitrite, dissolved phosphorus and total phosphorus concentrations were low. All other water quality chemistries were reflective of good water quality.

Stream: Tomahawk Creek

Site: Downstream of railroad crossing off Dry Bridge Road

Watershed: Upper Swift Creek

Subwatershed: Tomahawk

Creek

Approximate Drainage Area

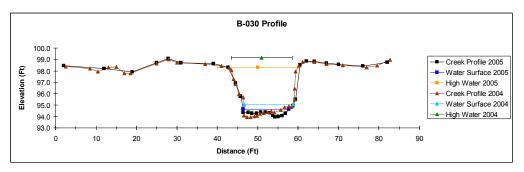
(acres): 1100

Stream Order: 1

Ecoregion: Triassic Basin (2)

Landuse: Forested

### **Stream Hydrologic Profile:**



### **Bioassessment:**

The bioassessment in 2005 decreased substantially from the "Slightly-Impaired" category observed for the past three years to a "Severely Impaired" status. During 2005, decreases were noted in total taxa richness and EPT taxa richness. A substantial increase in the percentage of collector/gather organisms, particularly Chironomidae (n=1048, 90.8% of sample) was noted. Interestingly an increase in *Chironomidae* taxa has been observed over the past two years. Percent composition of predators and scrapers were lower than in 2004. Some other organisms present in order of abundance were worms (n=32), crayfish (n=26) and *Cheumatopsyche* caddisflies (n=15).

### **Habitat Assessment:**

The instream habitat assessment declined from the "Comparable to Reference" score noted in previous years to a "Partially Supporting" condition in 2005. Decreases in metric scores within the substrate and instream cover section and lower flow conditions were the primary reasons for the observed decline.

### Water Quality:

Increased nutrients were observed during 2005. Elevated concentrations of ammonia (0.04 mg/L), nitrate/nitrite nitrogen (0.25 mg/L) and total phosphorus (0.035 mg/L) were noted. The nitrogen values were similar to the 2004 concentrations while the total phosphorus level was lower

Stream: Swift Creek

Site: Downstream of Otterdale Road

Watershed: Swift Creek

Reservoir

Subwatershed: Upper Swift

Creek

Approximate Drainage Area

(acres): 13696

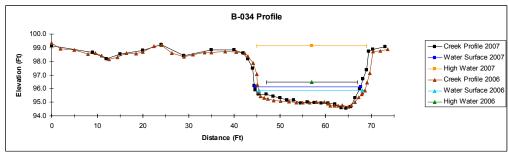
Stream Order: 4

Ecoregion: Triassic Basin (2)



Landuse: Forest, Upstream Wetland and Road Crossing

### **Stream Hydrologic Profile:**



### **Bioassessment:**

The bioassessment in 2007 improved from the "Slightly Impaired" condition observed since 2003 to a "Non-impaired" category. Total taxa and EPT taxa richness values increased and were among the largest recorded among all sites in 2007. The percent dominant taxa value was low indicating a well balanced community. The Hilsenhoff Biotic Index score was similar to the 2006 value and continued to indicate a community comprised primarily of pollution tolerant organisms. The collector/gatherer metric score increased as a result of fewer of these opportunistic feeders present in the sample and the proportion of predators and scraper taxa were excellent Fauna well represented in the sample included various *Chironomidae* species, flathead mayflies (*Stenonema*) and scuds (*Cragonyx*).

### **Habitat Assessment:**

Although an increase in the total score was observed in 2007, the assessment continued to indicate a "Non-Supporting" condition in 2007. Improved scores in most of the epifaunal substrate and available cover metrics were noted, however they were not substantial enough to influence the assessment category. Bank stability and vegetated cover remained marginal with the overall channel morphology the same as in previous years.

### Water Quality:

The observation of total hardness (30 mg/L as CaCO<sub>3</sub>) was among the highest concentrations noted at all sites in 2007. All other analyses were also indicative of good water quality. A County Utilities Water Quality Monitoring station is immediately upstream of this site and may provide the interested reader with several years worth of detailed water quality data.

Stream: Horsepen Creek

Site: Upstream of Otterdale

Road

Watershed: Swift Creek

Reservoir

Subwatershed: Horsepen

Creek

Approximate Drainage Area

(acres): 2378

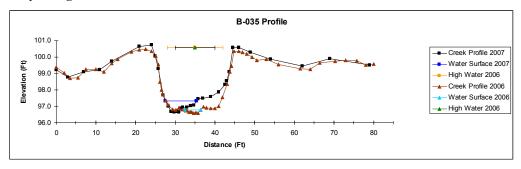
Stream Order: 3

Ecoregion: Triassic Basin (2)

Landuse: Forest



### **Stream Hydrologic Profile:**



### **Bioassessment:**

The bioassessment improved from the "Slightly Impaired" condition observed since the site was added in 2004 to a "Non-impaired" category in 2007. Substantial increases were noted in both the total taxa richness (n=32) and the EPT taxa richness (n=13) values. The percent dominant taxa value was low indicating a well balanced community. The Hilsenhoff Biotic Index score (4.2) was the lowest observed among all sites and indicated a benthic community dominated by pollution sensitive taxa. The collector/gatherer metric score increased as a result of fewer of these opportunistic feeders present in the sample. The proportion of predators and scraper taxa recovered were not as strong and were similar to previously observed values. Midge larvae (*Chironomidae*), *Amphinemura* stoneflies, blackfly larvae (*Simulium*) and rolledwinged stoneflies (*Leuctra*) were the most numerous taxa represented in the sample.

### **Habitat Assessment:**

The instream assessment remained the "Non-Supporting" condition observed in 2006. Aside from a slight improvement in pool variability, all other metric scores were similar to the previous year's values indicating little or no change in channel geomorphology and riparian structure.

### Water Quality:

All chemistries were reflective of good water quality. Nutrient levels were among the lowest recorded among all sites in 2007. A County Utilities Water Quality Monitoring station is immediately downstream of this site and may provide the interested reader with several years worth of detailed water quality data.

Stream: Little Tomahawk Creek

Site: Adjacent to Holding

Pond Lane

Watershed: Swift Creek

Reservoir

Subwatershed: Little Tomahawk Creek

Approximate Drainage Area

(acres): 1539

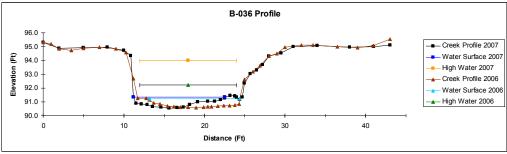
Stream Order: 3

Ecoregion: Triassic Basin (2)

Landuse: Residential, Forest



### **Stream Hydrologic Profile:**



### **Bioassessment:**

In 2007, the bioassessment continued to indicate the "Moderately Impaired" status observed in 2006. Most metric scores remained similar to previous observations indicating little change in the overall community structure of the stream. Although taxa richness improved slightly compared to 2006, the value was still among the lowest observed at all sites and was not substantial enough to influence the metric score. An increased abundance of collector/gatherer organisms observed in the sample during 2007 resulted in a decreased score for that metric. As noted in 2005 and 2006, EPT taxa richness was very poor (n=1), however the abundance of the EPT taxa observed (Common netspinner caddisfly larvae; *Cheumatopsyche*) was good (n=72; 25.4%). Midge larvae (*Chironomidae*), *Physella* snails and fingernail clams (*Pisidium*) were also well represented in the sample.

### **Habitat Assessment:**

The instream assessment score remained "Non-Supporting" in 2006 with conditions generally the same as those observed in the previous three years. Typical of creeks in the area, the stream's substrate is comprised largely of sand resulting in a general lack of instream habitat and cover for macroinvertebrates. The streams banks are not well vegetated and are prone to erosion during periods of high flow.

### Water Quality:

As in 2006, the total hardness value (30.0 mg/L as CaCO<sub>3</sub>) was the one of the highest observed at all sites. Concentrations of ammonia nitrogen (0.07 mg/L as N) and total phosphorus (0.08 mg/L as P) were high. Nitrate+nitrite nitrogen was slightly elevated. All other analyses were indicative of good water quality.

Stream: Westbranch

Site: Upstream of West

Branch Road

Watershed: Swift Creek

Reservoir

Subwatershed: Westbranch

Approximate Drainage Area

(acres): 1737

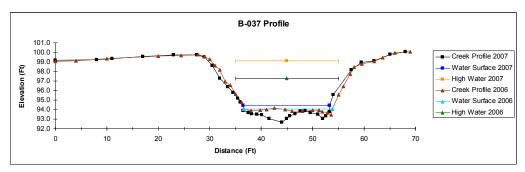
Stream Order: 3

Ecoregion: Triassic Basin (2)

Landuse: Residential, Forest



### **Stream Hydrologic Profile:**



### **Bioassessment:**

The bioassessment improved from the "Severely Impaired" condition observed in 2006 to a "Moderately Impaired" category in 2007. Total taxa richness was the lowest (n=13) observed among all sites in 2007. EPT taxa richness was also low. Improvements in the percent dominant taxa metric and Hilsenhoff Biotic Index score were noted indicating a slightly better balanced aquatic community compared to the previous year. An increase in the percent scrapers observed also contributed to the improved assessment score. Taxa well represented in the sample included midge larvae (*Chironomidae*) and worms.

### **Habitat Assessment:**

As in 2006, A "Non-Supporting" condition was observed for this site. Slight decreases in the epifaunal substrate/available cover metric and the pool substrate and variability metrics were noted. Slight improvements were observed in bank stability and bank vegetative cover.

### Water Quality:

General improvements in nutrient levels were observed at this site in 2007. The concentrations of ammonia nitrogen (<0.02 mg/L as N), nitrate+nitrite nitrogen (0.02 mg/L as N) and dissolved phosphorus (<0.05 mg/L as P) were at or below detection limits in 2007. The total phosphorus concentration (0.05 mg/l as P) was elevated but not to the degree observed in 2006. All other analyses were indicative of good water quality. A County Utilities Water Quality Monitoring station is immediately downstream of this site and may provide the interested reader with several years worth of detailed water quality data.

Stream: Tomahawk Creek

Site: Downstream of Old

Hundred Road

Watershed: Swift Creek

Reservoir

Subwatershed: Tomahawk

Creek

Approximate Drainage Area

(acres): 2658

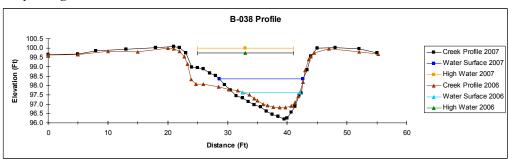
Stream Order: 3

Ecoregion: Triassic Basin (2)

Landuse: Forest, Residential



### **Stream Hydrologic Profile:**



### **Bioassessment:**

In 2007, the assessment remained unchanged from the "Slightly Impaired" status noted in 2006. Total taxa richness was good (n=25) and EPT taxa richness improved with 12 distinct taxa recovered. The Hilsenhoff Biotic Index score remained low indicating a benthic community dominated by pollution sensitive taxa. The percent dominant taxa metric score declined due to a slightly higher proportion (37.2%) of midge larvae (*Chironomidae*) recovered in the sample. As in the previous year, a low percentage of collector/gatherer organisms were present in the sample and the proportion of predator and scraper organisms observed were good. Other abundant macroinvertebrates in the sample included *Amphinemura* stoneflies, blackfly larvae (*Simulium*) and common stoneflies (*Perlesta*).

### **Habitat Assessment:**

As in 2006, a "Partially Supporting" condition was observed for this site in 2007. Slight increases in sedimentation and changes in pool substrate characterization related to larger amounts of sediment were noted in 2007. The stream's banks remained sparsely vegetated and continued to exhibit a high degree of erosion. The riparian vegetative zone width (buffer) was optimal for the protection of the stream.

### Water Quality:

In 2007, the measured pH value (8.7 units) was the greatest observed at all sites. The concentrations of ammonia nitrogen (0.06 mg/L as N), nitrate+nitrite nitrogen (0.12 mg/L as N) and total phosphorus (0.06 mg/L as P) were elevated. All other analyses were indicative of good water quality. A County Utilities Water Quality Monitoring station is immediately upstream of this site and may provide the interested reader with several years worth of detailed water quality data.

### **Discussion:**

Table 2 presents a summary of the bioassessment categories observed over the past five years. The most recent assessments (2007) indicated that the six streams investigated in the Upper Swift Creek Watershed were divided among the "Moderately Impaired", "Slightly Impaired" and "Non Impaired" biological categories. Improvements in categorical assessments were observed at three of these reaches in 2007. At Swift Creek (B-034) and Horsepen Creek (B-035), the bioassessment increased from a "Slightly Impaired" to a "Non-impaired" status in 2007, largely as a result of improved total taxa and EPT taxa richness metric scores. An improved condition was also noted at Westbranch (B-037) where a benthic macroinvertebrate community shift towards more pollution sensitive taxa and scraper organisms was observed. In 2007, a decline in categorical assessment was observed at Otterdale Branch (B-028) where the status shifted from a "Slightly Impaired" to a "Moderately Impaired" condition. This decrease was due primarily to a substantial increase in the proportion of midge larvae in the sample (69.5%) that yielded decreased scores in both the percent dominant taxa and percent collector/gatherer metrics. The two remaining stream sites exhibited no change in categorical scores in 2007. A "Slightly Impaired" condition was noted at Tomahawk Creek (B-038), and a "Moderately Impaired" status was observed at Little Tomahawk Creek (B-036).

Table 2. A summary of Bioassessment Categorical Scores observed in the Upper Swift Creek Watershed. 2002 – 2007.

Creek Watersheu, 2002 – 2007.							
		Bioassessment Category					
Site	Stream	Severely	Moderately	Slightly	Non		
		Impaired	Impaired	Impaired	Impaired		
B-002	Turkey Creek		2004	2003	2002		
B-010	Little Tomahawk Creek	2005	2004	2002/2003			
B-011	Trib to Swift Creek	2002/2003	2004	2005			
B-012	Turkey Creek	2003	2002				
B-013	Blackman Creek				2002		
B-028	Otterdale Branch		2002/ <b>2007</b>	2004/2005/2006	2003		
B-030	Tomahawk Creek	2005		2002/2003/2004			
B-034	Swift Creek			2003/2004/2005/	2007		
				2006			
B-035	Horsepen Creek			2004/2005/2006	2007		
B-036	Little Tomahawk Creek	2005	2004/2006/				
			2007				
B-037	Westbranch	2006	2007				
B-038	Tomahawk Creek			2006/ <b>2007</b>			

Table 3 presents a summary of the habitat assessment categories observed for the past five years. Assessments since 2002 have continually demonstrated that the majority of the streams investigated in the Upper Swift Creek Watershed possess either "Partially Supporting" or "Non-Supporting" habitat. In 2007, four of the six assessed sites possessed "Non-Supporting" habitat. Traits common among these streams included lack of instream habitat and poorly vegetated banks with high degrees of erosion present. The

only decrease noted in assessment category was observed at Otterdale Branch (B-028) where an increase in sedimentation and lower flow was observed in 2007.

Table 3. A summary of Habitat Categorical Scores observed in the Upper Swift Creek Watershed, 2002 – 2007.

		Habitat Assessment Category			
Site	Stream		Partially		Comparable
		Non Supporting	Supporting	Supporting	to Reference
B-002	Turkey Creek	2004	2002/2003		
B-010	Little Tomahawk Creek	2004/2005	2002	2003	
B-011	Trib to Swift Creek	2002/2003/2004	2005		
B-012	Turkey Creek	2002/2003			
B-013	Blackman Creek		2002		
B-028	Otterdale Branch		2002/2003/	2004/2005/	
			2007	2006	
B-030	Tomahawk Creek	2002	2005		2003/2004
B-034	Swift Creek	2003/2006/ <b>2007</b>	2004/2005		
B-035	Horsepen Creek	2004/2006/ <b>2007</b>	2005		
B-036	Little Tomahawk Creek	2004/2005/2006/			
		2007			
B-037	Westbranch	2006/ <b>2007</b>			
B-038	Tomahawk Creek		2006/ <b>2007</b>		

A comprehensive suite of chemical parameters has been collected since 2002. These measurements are collected to provide a general water quality "snapshot" at the time the biological and habitat assessments are obtained. A more detailed long-term description of water quality in the Upper Swift Creek Watershed is available from the Department of Utilities' Source Water Monitoring Program (Swift Creek Reservoir) reports. For the past five years, instream measurements of dissolved oxygen, conductivity, total dissolved solids and temperature have yielded values that were within Virginia state water quality standards and normally expected ranges. Observations of pH over the years have shown that several streams in the Upper Swift Creek Watershed have been acidic to the point of being less than the 6.0 unit standard set by the State of Virginia's Department of Environmental Quality, however since 2006, no streams in the Upper Swift Creek Watershed possessed pH values lower than 6.0 units (Table 4).

Table 4. Streams in the Upper Swift Creek Watershed with pH values below Virginia DEQ standard of 6.0 units, 2002 – 2007. Asterisks denote no observations.

pH (units)	2002	2003 2004		2005	2006	2007
5.1	B-013	*	*	*	*	*
5.2	*	*	B-011, B-035	*	*	*
5.5	*	B-010, B-012	*	*	*	*
5.6	*	B-011	B-002	*	*	*
5.7	*	B-030	*	*	*	*
5.8	B-028	*	*	B-035	*	*
5.9	B-010, B-011, B-012	B-002	*	*	*	*

Fecal coliform densities observed in the tributaries of the Upper Swift Creek Watershed have largely been below Virginia's one-time sampling standard of 400 MPN/100ml. No streams in the Upper Swift Creek Watershed possessed fecal coliform densities in violation of the standard during the spring 2007 surveys.

Table 5. Sites at which fecal coliform densities were  $\geq$ 400 MPN/100m, 2002 – 2007. Asterisks denote no violations.

		Fecal Coliform Density (Most Probable Number/100ml)					
Site	Stream	2002	2003	2004	2005	2006	2007
B-010	Little Tomahawk Creek	*	*	500	*	*	*
B-011	Trib to Swift Creek	*	1600	≥1600	*	*	*
B-030	Tomahawk Creek	*	*	≥1600	*	*	*
B-037	Westbranch	*	*	*	*	500	*

Nutrient concentrations as measured by total/dissolved phosphorus and ammonia and nitrate/nitrite nitrogen have varied among sites over the past five years. Most recent data (2007) indicate elevated phosphorus and nitrogen concentrations were present at several sites in the Upper Swift Creek Watershed (Table 6). The most noteworthy increases observed in 2007 occurred at Little Tomahawk Creek (B-036) and Tomahawk Creek (B-038).

Table 6. Nutrient concentrations observed in the Upper Swift Creek Watershed, Spring 2007. Values in red bold type are concentrations considered elevated.

		2007 Nutrient Concentrations (mg/L)				
Site	Stream	Total	Dissolved	Ammonia	Nitrate/Nitrite	
		Phosphorus	Phosphorus	Nitrogen	Nitrogen	
B-028	Otterdale Branch	< 0.05	< 0.05	0.10	0.03	
B-034	Swift Creek	< 0.05	< 0.05	< 0.05	< 0.02	
B-035	Horsepen Creek	< 0.05	< 0.05	< 0.05	< 0.02	
B-036	Little Tomahawk Creek	0.08	< 0.05	0.07	0.10	
B-037	Westbranch	0.05	< 0.05	< 0.05	0.02	
B-038	Tomahawk Creek	0.06	< 0.05	0.06	0.12	

Typically, total suspended solids measurements at the time of sampling within the Upper Swift Creek Watershed have been less than 20 mg/L. In past reports, the greatest total suspended solids concentrations observed have occurred at Tomahawk Creek (25 mg/L, 2004) and the Tributary to Swift Creek (26 mg/L, 2004). In 2007, no total suspended solids measurements were greater than 5 mg/L. Since 2002, the majority of Biological Oxygen Demand determinations have been less than 3.0 mg/L. The greatest BOD value recorded in the Upper Swift Creek Watershed was 13.8 mg/L and occurred at the upper Little Tomahawk Creek site (B-010) in 2005. In 2007, all BOD values were less than the reporting limits (<2 mg/L) of the contract laboratory. Hardness measurements during the past five years have continually indicated soft water (<85 mg/L as CaCO<sub>3</sub>) throughout the Upper Swift Creek Watershed.

An index of water quality using the biological data, habitat assessment and select chemical parameters was developed to provide for an overall evaluation of stream health in the County. The chemical parameters used were those that possessed a Virginia State Water Quality Standard (pH, Dissolved Oxygen and Fecal Coliform). The index generated a numerical score that corresponded to a level of quality for the stream segment. The results of the analysis are outlined in table 7 and are reflective of all monitored streams in the watershed for the period of 2002 to 2007.

In 2007, improvements in stream health were noted at Swift Creek (B-034) and Horsepen Creek (B-035) where the assessment categories increased from "Fair" to "Good", and at Westbranch (B-037) where the category increased from "Poor" to "Fair" (Table 7). At Westbranch, declines in fecal coliform densities combined with an improved bioassessment categorical score were the factors responsible for the better index value. At both Swift Creek and Horsepen Creek, improvements to the bioassessment score were the primary reasons for the noted increase. The only decline in index category score during 2007 was noted at Otterdale Branch (B-028) where the value decreased from a "Very Good" to a "Fair" status (Table 7). This decline was attributed to the decrease in bioassessment category from increased midge larvae abundance and in the habitat condition from the result of increased sedimentation and lower flows during 2007. The remaining two sites demonstrated no change from the previous year.

Table 7. Categorical scores of the index of water quality analysis, 2002 - 2007. Values in red represent categorical assessments of most recently monitored streams.

Water Quality Category Current 2002 2003 2004 2005 2006 2007 Site Stream Assessment B-002 Turkey Creek Very Good Fair Poor Poor Little Tomahawk B-010 Good Creek Fair Poor Poor Poor B-011 Trib to Swift Creek Poor Poor Poor Good \* Good \* \* B-012 Turkey Creek Poor Poor Poor B-013 Blackman Creek Good Good Very Very Very B-028 Otterdale Branch Fair Good Good Good Good Fair Fair Very B-030 Tomahawk Creek Fair Good Good Fair Fair B-034 Swift Creek Good Good Fair Good Fair Good \* B-035 Horsepen Creek Fair Fair Fair Good Good B-036 Little Tomahawk \* Fair Creek Fair Poor Fair Fair \* Westbranch Fair B-037 Poor Fair \* B-038 Tomahawk Creek Good Good Good

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